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EUROCAE ED247 (VISTAS) Rev B On the way evolutions ettc2022

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Abstract:
Since 2018, each year, a few papers on EUROCAE standard ED247 (aka VISTAS) have already been presented in the frame of the ETTC. This standard defines a light and efficient way to virtualize avionic signals and digital buses on a standard communication bus like Ethernet in the frame of full simulation or hybrid benches.

After a brief summary of the standard main concepts and benefits associated, the presentation will be focused on the new functionalities and performance improvements that are currently discussed for the next release of the standard (Rev B) which include:

- New channel types like ARINC 708,
- New transport protocols like DDS, RDMA in addition to the UDP current one,
- ED247 components command and control,
- State machine & time management,
- Virtual components internal data monitoring,
- Failure injection and data overwriting limited to data exchanged between virtual components,
- Health monitoring.

Key words: ED-247, VISTAS, Virtual testing, Test Bench, Simulation.

Introduction

The purpose of this paper is to focus on currently discussed evolutions of the EUROCAE standard ED-247 (aka VISTAS) in the frame of the Rev.B

The paper first recalls the main outlines of the EUROCAE standard ED-247:

- History,
- Working Group Members,
- Main principles,
- Use cases,

Next, the paper presents the “on the way” evolutions of the standard, focused on the following topics:

- ED-247 State machine description,
- Command&Control generic mechanism,
- Instrumentation,
- Health Monitoring,
- New transport protocols in addition to Ethernet UDP,
- New type of signal taken into account.

ED-247: History

The EUROCAE Workgroup 97 in charge of ED-247 was founded in 2013.

The first release of the standard was published in November 2017 including the virtualization of AFDX, Arinc 429, CAN Bus, DISCRETE, ANALOG and Non avionic data.

In March 2020, the release A was published bringing a bunch of clarifications and additional signals virtualization: serial line, MIL-STD-1553, voice and video.

The release B is now planned for Q2 2023. It will include additional capabilities like Control & Command mechanism, Instrumentation, Definition of the virtual component delivery format and additional transport protocols.

These additional capabilities will be described in detail in the following paragraphs.

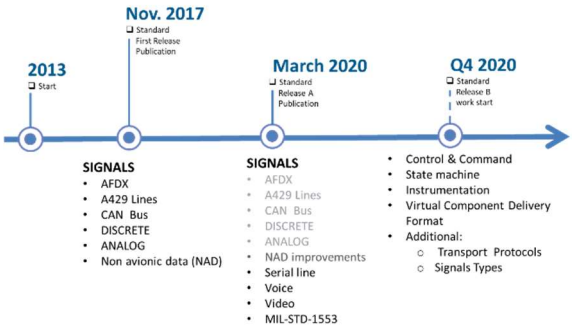


Fig. 1. ED-247 history.

ED-247: Working Group Members

Members within ED-247 Working Group are representing names in the aerospace (such as AIRBUS, DASSAULT or BOEING) along with key instrumentation and flight simulator suppliers.

ED-247: Standard in a nutshell

ED-247, also called VISTAS (Virtual Interoperable Simulation for Tests of Avionics Systems) is defined under the umbrella of the EUROCAE organization in the frame of the Working Group 97.

The main objective of the standard is to improve the integration test process, by reducing drastically the associated costs and delays and by starting this process as soon as possible during the development cycle.

To achieve this target, the standard proposes a way to share easily models between the different actors, to use these models in the frame of full simulations or hybrid ones mixing real or virtual components not necessarily collocated and to virtualize the communication exchanges between the different elements on an IT network.

The standard provides a way to transport all the information exchanged between equipment, not any more through multiple wirings (discrete, analog, bus) but through an IT network (Cf. *Fig. 2*).

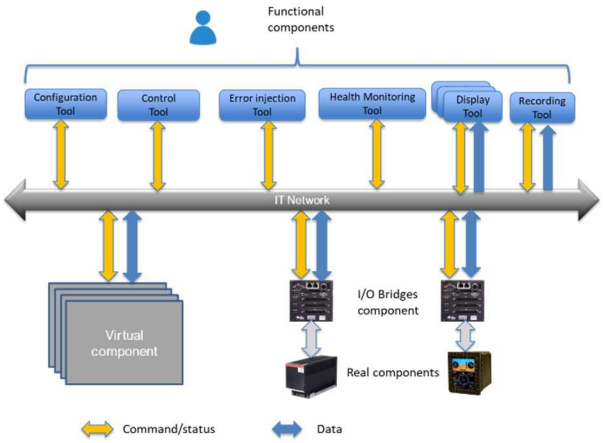
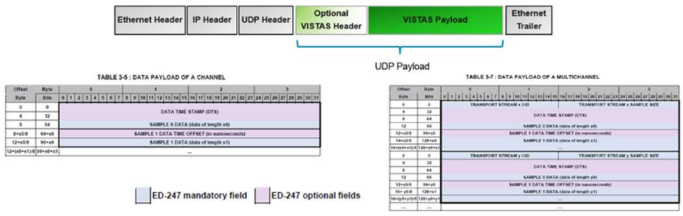


Fig. 2. ED-247: High level architecture and components.

These information are acquired, timestamped, multiplexed and stored into data packets sent on the network with the following constraints:

- Minimizing the latency introduced by the virtualization as far as possible,
- Limiting the CPU, Memory, Bandwidth usage,
- Reproducing with a high accuracy the timing of the original signal.

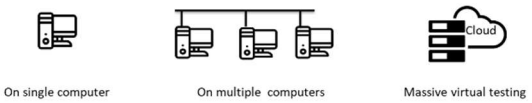
For the releases ”-” and “A”, the transport protocol used is Ethernet UDP.



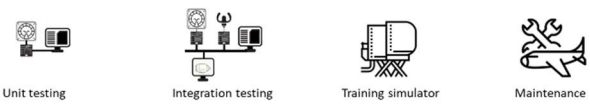
ED-247: Use cases

The ED-247 is usable on both sides of the V development cycle:

- **Full simulation (Left side of the V)**



- **With hardware in the loop (right side of the V)**



ED-247 Rev. B: Working groups process

The ED-247 Rev. B work began in the end of 2020.

The release B is planned for Q2 2023.

In the meantime, the working group (split in different sub-groups for different topics) is meeting periodically to discuss the different subjects.

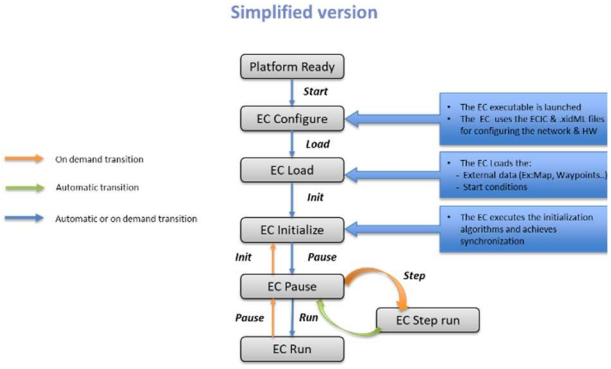
The following paragraphs summarize the actual status of the main improvements introduced by the rev B:

- ED-247 State machine description,
- Command & control generic mechanism,
- Instrumentation,
- Health Monitoring,
- New transport protocols in addition to Ethernet UDP,
- New type of signal taken into account.

Warning: The following paragraphs reflect the current state of the working group's discussions. As the release "B" document is still under construction the final document might be slightly different.

ED-247 Rev. B: State machine

A simplified version of the State machine is described below:



ED-247 Rev. B: Command and Control

Applicability:

The same generic Command-and-Control mechanism/Protocol will be used for all the topics where commands are defined by the standard:

- Load and configure the EC component,
- Request state machine transition,
- Instrumentation commands (Inspection request, Failure & Overwriting demand),
- Asynchronous Health monitoring request (TBC),
- Power supply management (TBC),
- Time management (TBC),
- Functional, Virtual or Bridge components specific command.

Command & response Block structure

Different solutions have been studied:

- Binary structure like defined in Rev "-"
- XML using a schema derived from the one used by XML-RPC,
- JSON with an ED-247 proprietary schema,
- JSON using a schema like the one used by the JSON-RPC.

The last solution appears to be the preferred one (TBC) due to its compacity, flexibility and compatibility with the execution of multiple command in parallel.

```
{
    "jsonrpc": "2.0",
    "ID" : "132",
    "method": "Monitoring.New",
    "params": [
        {"name": "Variable_Id", "type": "array", "value": [
            {"type": "int", "value": 7},
            {"type": "int", "value": 1247},
            {"type": "int", "value": 91},
            {"type": "int", "value": 42}
        ]}
    ],
}
```

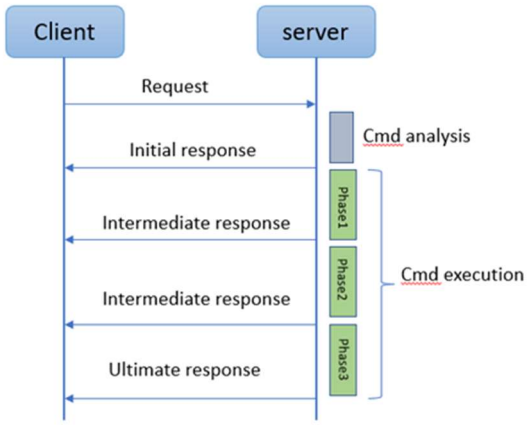
Multiple steps response

As the execution of some commands could take time, the standard will allow two different types of response mechanism: One step or N steps

One Step: The response is sent immediately with an error description if the command is detected as not valid or after the command execution, with the results, if the command is valid.

N Steps: The first step is sent immediately to mention that the command is well received (command valid or not). The intermediate steps are reporting the progress of the command execution. The ultimate step is reporting the command termination and the result.

The First step answer could be used by the sender to secure the transmission thanks to a timeout if the transport protocol in not 100% safe.



Transport protocol

Different protocol could be used:

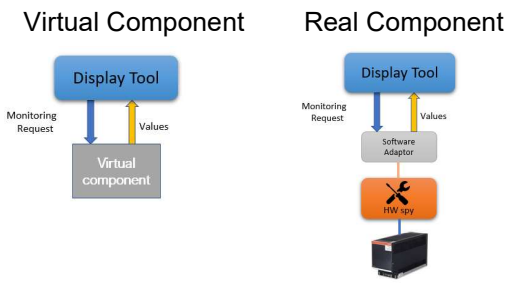
- HTTP: in this case, if the format of the command block is in line with the .xml schema presented, the implementation is fully the XML-RPC with some additional constraints,
- TCP: The packet lost management will be done through the protocol itself,
- UDP: The latency will be reduced and the multicast command allowed but the good reception must be managed thanks to the first step response
- QUIC (Quick UDP Internet Connections) on the top of UDP which bring better performance, multiple exchange through the same connection and crypto basically mandatory but extension can be used to make it optional,
- HTTP/3 which run over QUIC,
- Web Sockets.

Due to its simplicity and efficiency, UDP is the one that will probably be retained for at least the release B.

ED-247 Rev. B: Instrumentation

The instrumentation part covers two different functionalities.

Regarding the data monitoring: The standard will provide mechanisms allowing the inspection of internal variables of all the ED-247 components (real or virtual) with exactly the same operating modes.



The corresponding values could be received only once or periodically.

Regarding the failure Injection: The standard will provide mechanism allowing the perturbation of data exchanged between the components. This perturbation could be applied at the source or at the destination. The failure injection of component internal variables is out of the scope of the rev B.

ED-247 Rev. B: Health monitoring

The role of the health monitoring part of the standard will be to specify:

- ED-247 component heartbeat mechanism and format. This Heartbeat will provide the global status of the component but potentially also the one of its visible subparts.
- The error logging process, format and associated command if any (like the one requesting the level of detail requested).

ED-247 Rev. B: EC delivery format

In order to facilitate the exchanges of virtual components between organizations, the delivery format will be defined in the Rev B specification. It will be based on a .zip file with a predefined structure.

ED-247 Rev. B: Additional Transport protocols

In order to improve the performances and the functionalities of the virtualization process, different transport candidates have been proposed:

- RDMA: Reduces the latency and the packet lost probability,
- TSN: Brings deterministic capability,
- DDS: Procures some cybersecurity aspects and abstraction of the physical transport layer.

The figure below presents the main benefit of RDMA vs UDP:

The main targeted benefits of this protocol are:

- A strong latency reduction (the Lowest latency reachable on Ethernet up to less than 1.3 µs),
- A significant latency jitter reduction,

- An ultra-low CPU overhead,
- A packet lost reduction,
- A capability to offer light multicast message transfer,
- An efficient usage of the existing network infrastructure,
- A message routing capability over WAN.

ED-247 Rev. B: New signal type introduced

ARINC 708 is a standard used by airborne pulse Doppler weather radar systems on commercial aircraft. It is based on a 1600 bits data frame, composed of a 64 bits header followed by a data section consisting of 512 bins of 3bits each.

The A708 Packet structure proposal is described below:

Offset Byte	Byte Bits	0	1	2	3
0	0	DATA TIME STAMP (DTS)			
4	32				
8	64	A708 MESSAGE SIZE		A708 MESSAGE (data of length x0) ...	
		... A708 MESSAGE (data of length x0)		ERRORS	
10+2+x0/8	96+x0	SAMPLE 1 DATA TIME OFFSET			
12+4+x0/8	128+x0	A708 MESSAGE SIZE		A708 MESSAGE (data of length x1) ...	
		... A708 MESSAGE (data of length x1)		ERRORS	
18+2+(x0+x1)/8	160+x0+x1	...			

A664 message | ED-247 mandatory fields | ED-247 optional fields

Conclusion

The ED-247 standard Rev. A, published in March 2021, achieves a maturity level compatible with operational implementation. It has already demonstrated its capacity to reduce the development cycle costs and delays.

The Rev B that will be published Q2 2023 will bring:

- Additional functionalities: Component Control & Command, access to internal variables of the virtual/real components, error injection and value overwriting, standardization of the virtual component delivery format, virtualization of the ARINC 708.
- Performance improvements especially in terms of latency thanks to the introduction of new transport protocols.

References

[1] ED-247A - Technical Standard for Virtual Interoperable Simulation for Tests of Aircraft Systems in Virtual or Hybrid Bench.

https://eshop.eurocae.net/eurocae-documents-and-reports/ed-247a/